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Conservative Surgery on the Battlefield and First Aid to the Wounded.

BY N. SENN, M.D., PH.D., LL.D.

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CONSERVATIVE SURGERY ON THE BATTLE-FIELD AND FIRST AID TO THE WOUNDED.

Conservatism will characterize the military surgery of the future. The two great sources of danger that face the wounded soldier upon the battle-field—hemorrhage and infection—will be greatly diminished by additional and improved hemostatic measures, and the more general and effective application of the principles of aseptic and antiseptic surgery. Mutilating primary operations will be limited to injuries with extensive destruction of the soft parts and complications involving large vessels and nerves which in themselves are sufficient to arrest the nutrition of the injured limb. Gunshot injuries of bones and joints will no longer determine the propriety of primary resection and amputation, and the danger of penetrating wounds of any of the large cavities of the body will be greatly diminished by the prompt employment of measures calculated to prevent septic infection, and other immediate and remote complications. I take it for granted, that I am expected on this occasion to discuss briefly the salient topics which will engage the attention of the military surgeons of future wars, and which will enable them to reduce the death rate, diminish suffering, save limbs, and prevent painful remote complications in case of bullet and other wounds which heretofore demanded primary mutilating operations, or, if treated upon conservative plans, subjected the soldier to imminent danger to life from septic complications.

Conservative surgery on the battle-field consists in rendering prompt and efficient aid to the wounded.



FIG. 1.—Elevation of the upper extremity in the treatment of hemorrhage.

To accomplish this successfully is the desire and aim of the military surgeons of all civilized nations. A well-trained hospital corps is now looked upon as an essential constituent of every modern military body. In our own country the Army and Navy, as well as the National Guards of the different States, are making ample preparations for effective first aid to the wounded, in the event of war, by the careful training of soldiers selected for Hospital Corps service. The practice of conservative surgery upon the battle-field will, of necessity, be intrusted largely to the educated, well-trained, non-combatant soldier. It is the character and efficiency of his work that will determine the fate of the wounded. I shall limit my remarks to the discussion on the work to be done by the surgeon and his helpmates, the members of the Hospital Corps, in caring for the wounded upon the battle-field, which will embrace: 1, the treatment of hemorrhage; 2, to counteract shock; 3, primary dressing; 4, immobilization; 5, transportation.

Temporary Hemostasis.—A large percentage of deaths upon the battle-field has been caused by the immediate result of hemorrhage. It is to be expected that the small calibre bullet, owing to its greater velocity and penetrating power, will cause death more frequently from primary acute hemorrhage than the round or large conical bullet of the past, because the wounds inflicted by it resemble more nearly incised than contused wounds as was formerly the case. There can be but little doubt that the old weapon produced wounds which were more liable to be followed by secondary hemorrhage, induced by the sloughing of the large area of contused tissue surrounding the tubular wound made by the bullet. The absence of this extensive area of contusion and laceration in wounds of large blood vessels made by the new bullet will increase the danger from primary hemorrhage, and will, consequently, demand more frequently and urgently in their treatment the employment of prompt and efficient hemo-

static measures. The treatment of hemorrhage upon the battle-field will be governed by the size and character of the vessel wounded and the part or organ injured. A distinction between arterial and venous hemorrhage is impracticable as far as the



FIG. 2.—Gun-stack for elevation of the lower extremity.

immediate treatment by non-professional assistants is concerned. Ligation of a blood vessel upon the battle-field, either at the point of injury or in its continuity, will be done only in exceptional cases. In

the majority of instances this part of the treatment will be consigned to the surgeons in charge of the first dressing station or the field hospital. In rendering the first aid to the wounded, hemorrhage should be diminished or arrested by such means and measures as are always at hand, or that can be readily extemporized and can be safely and efficiently applied by members of the Hospital Corps.

Elevation of Limb.—The force of gravitation answers an exceedingly useful purpose in arresting hemorrhage from the smaller vessels of the extremities. By placing the injured limb in a vertical position, intravascular pressure is so much diminished that spontaneous arrest of hemorrhage is often effected by this simple procedure, even when a vessel the size of the palmar arches is injured, but its greatest value and widest range of application will be in the treatment of venous and parenchymatous hemorrhage. The elevated position should be maintained for some time after the hemorrhage has ceased, or until more efficient measures can be employed. The manner of effecting and maintaining elevation as a hemostatic agent is shown in Figs. 1 and 2.

Digital Compression.—In the treatment of hemorrhage from large vessels accessible to digital compression, this method offers a reliable means of controlling hemorrhage. The members of the Hospital Corps are familiarized with the exact location of the principal arteries of the extremities and the method of arresting hemorrhage by digital compression.

The compression must be continued uninterruptedly until the bleeding vessel can be tied, or pressure can be replaced by elastic constriction or the antiseptic tampon.

Flexion.—Forced flexion as an hemostatic agent was introduced by Adelman. Genuflexion is a prompt and efficient method of arresting hemorrhage from the popliteal artery and its branches. Brachial hyperflexion answers the same purpose in the treat-

ment of hemorrhage from the brachial artery from a point opposite the elbow joint or any of its branches below this point.

In making genuflexion, the belt, suspender, gun-strap, or triangular bandage should be passed through a slit in the shoe or boot above the heel, after which the ends are firmly tied over the base of the thigh where it is fastened to the pants or drawers

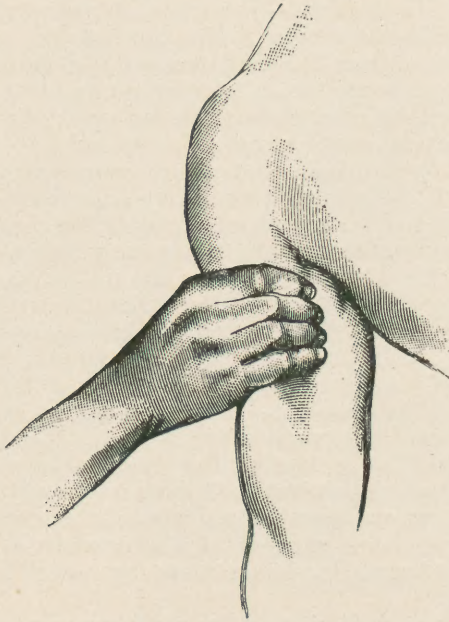


FIG. 3.—Digital compression of brachial artery.

with a safety pin. Forced flexion of the forearm can be made with an ordinary handkerchief.

Elastic Constriction.—Elastic constriction, properly applied, is a safe and absolutely reliable hemostatic agent in preventing and controlling hemorrhage from any of the vessels of the extremities. Introduced and popularized by the greatest military surgeon of

the present time, von Esmarch, it is applied wherever surgery is practiced, but its employment is of special value upon the battle-field. The elastic constrictor has displaced almost entirely the ordinary tourniquet. Preliminary compression of the limb by an elastic bandage is unnecessary, as simple elevation continued for a few moments will render the limb sufficiently bloodless for all practical purposes. The harmful effects of elastic constriction improperly applied are temporary, and even permanent paralysis of one or more of the principal nerves injured by the linear compression. To prevent such a complication it is necessary to compress the limb at a point where the main nerves are adequately protected by muscles and to bring to bear no more pressure than is necessary to realize the object for which the constriction is made—to interrupt completely both the venous and arterial circulation. The arm should be constricted at a point corresponding with the middle of the deltoid muscle or over the top of the shoulder and the thigh near its base.

To avoid harmful linear constriction it is advisable to use an elastic band at least an inch in width or a suspender, and if the constrictor encircles the limb more than once, to bring each turn separately down upon the surface of the limb and not overlap each other. An assistant should hold the limb firmly in a vertical position when the constrictor is applied over the side of the limb where the large blood vessels are located, and the constriction quickly and firmly made so as to interrupt at once, completely, both the arterial and venous circulation. How long is it safe to exclude from a limb the circulation by elastic constriction? This is an important question which presents itself with special force in the practice of military surgery. I made, a few years ago, an interesting series of experiments on dogs for the purpose of formulating an authoritative answer to this question. Elastic constriction was applied by using rubber tubes the size of an ordinary

lead pencil, and the constriction was continued from one to twenty-six hours. Temporary paralysis was observed in a number of cases. Gangrene of the limb below the point of constriction resulted only in one case, and in this instance the constriction was continued for twenty-four hours, while the dog in which the constriction was continued for twenty-six hours recovered in a short time perfect use of the



FIG. 4.—Digital compression of femoral artery.

limb. The blood contained in the arteries and veins below the point of constriction remained fluid and retained its intrinsic functional properties for this length of time after complete exclusion from the general circulation. Elastic constriction is not attended by any special danger from this source. Every surgeon has had cases in which elastic constriction was continued for several hours, in the performance of

difficult and tedious operations, without witnessing any untoward, immediate or remote results from the prolonged interruption of the circulation. I have learned of a number of cases of railway injuries in which elastic constriction was continued from seven to twelve hours without any obvious harmful results. From the results of my own experiments and the clinical data on elastic constriction as a hemostatic resource, I am satisfied that it is safe to exclude the circulation from a limb for four to six hours without incurring any special risks of gangrene or permanent damage to large nerve trunks. The exact limit of prolonged constriction in man has not been determined, and I should consider it unwise to continue it beyond the time specified. In the majority of cases during this time the wounded will be brought to the attention of surgeons when the injured vessel is exposed and tied, or elastic constriction is replaced by direct compression.

Antiseptic Tampon.—The antiseptic tampon is a convenient and very useful hemostatic agent in the treatment of accidental hemorrhage. The antiseptic package with which every soldier of civilized warfare will be supplied can be used advantageously for this purpose. It will prove of special value in the arrest of hemorrhage from the vessels of the scalp, face and intercostal arteries, and in the treatment of open lacerated and sabre wounds. The surface to be compressed should be dusted with the antiseptic powder contained in the package, and with the hygroscopic antiseptic material composing the balance of the package a graduated compress is made, the apex of which is placed in contact with the bleeding vessel, and the necessary degree of pressure secured by a circular bandage with or without the use of an extemporized splint according to the location of the vessel, or the relations of the injured vessel to the underlying bone.

Vessel injuries treated by antiseptic tamponade will seldom require ligation as the tampon, if the

wound remains aseptic, is allowed to remain until the lumen of the vessel has become obliterated permanently by thrombosis and cicatrization.

Internal Hemorrhage.—The prompt and proper treatment of internal hemorrhage will constitute one of the crowning triumphs of surgery upon the battlefield. The direct treatment of the injured vessels by early invasion of any of the three large cavities of the body will be the means of saving many lives which heretofore were doomed to certain death. This

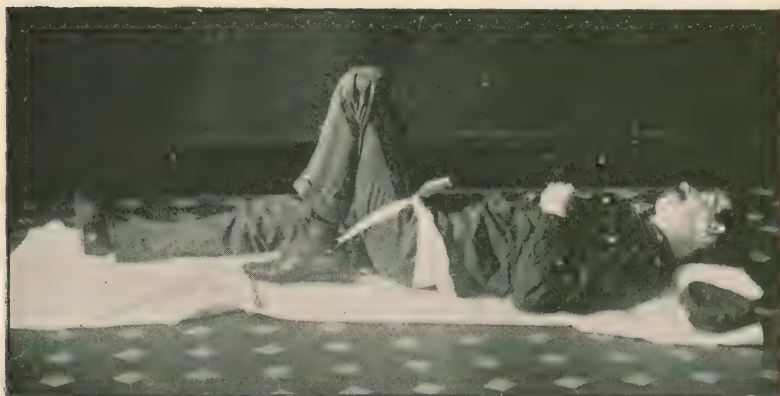


FIG. 5.—Genuflexion in the treatment of hemorrhage from the popliteal artery and its branches.

part of the surgeon's work will be done at the first dressing station or the field hospital.

What can be done behind the fighting line in such cases to bridge over the time until such services can be rendered to the injured? In hemorrhage from the intracranial vessels caused by bullet wounds, it would be dangerous to plug the wounds of entrance and exit as the accumulation of blood in the cranial cavity would result in death from cerebral compression. The escape of blood should be favored by inserting into the track made by the bullet a strip of

aseptic or iodoform gauze. This will not only serve a useful purpose as a capillary drain, but by bringing in contact with the injured vessels an aseptic foreign substance the spontaneous arrest of hemorrhage by thrombosis is favored. The gauze drain should be secured on the surface of the wound with a safety pin and the wound or wounds protected against infection by an antiseptic dressing retained in place by the triangular bandage. By this treatment many cases will reach the field hospital for a timely intracranial operation. In bullet and stab wounds of the chest, complicated by hemorrhage from the intercostal arteries, the antiseptic tampon is the proper treatment. Packing of the tubular wound with an antiseptic hygroscopic material will not only succeed in arresting the hemorrhage, but will serve at the same time as an efficient capillary drain and protect the cavity of the chest and its contents against infection. In hemorrhage from injuries of the organs of the chest, firm circular compression of the chest directly over the wound already protected against infection by an antiseptic dressing constitutes a valuable indirect hemostatic measure.

Immobilization of the chest wall by circular compression diminishes the functional activity of the lungs, and in doing so exerts a favorable influence in arresting hemorrhage from this organ. The cartridge belt or gunstrap can be used to the greatest advantage in limiting the respiratory movements of the chest. I believe that this conservative treatment of penetrating wounds of the chest will yield better results than injection of filtered air, absorbable aseptic solutions, or treatment by rib resection, free incision, and attempts to ligate the bleeding vessels. In penetrating wounds of the abdomen the prime indication in the future treatment of such injuries will be to prevent death from hemorrhage. Visceral wounds of the abdominal organs, notably the liver, spleen and mesentery, usually give rise to profuse and often fatal hemorrhage. The hemorrhage is more fre-

quently venous and parenchymatous than arterial. In my address last year before this Association, I urged the importance of early operative interference in such cases, and mentioned hemorrhage and the



FIG. 6.—Forced flexion of forearm in arresting hemorrhage from the brachial artery opposite the elbow joint or any of its branches below this point.

direct treatment of visceral wounds as ample indications to justify prompt, active interference. In injuries of vessels below the bifurcation of the abdominal aorta, attempts should be made to prevent death

from hemorrhage upon the battle-field by resorting to the use of some sort of compression with a view to interrupting the circulation in the aorta above the bleeding point. Esmarch's method, shown in Fig. 11, can be extemporized in a few moments, as it requires no instrument of special construction and meets the indications more completely than the various instruments devised for this purpose.

The method of Brandis is equally simple and effica-



FIG. 7.—Elastic constriction of upper extremity. (After Seydel.)

cious. As hemorrhage from any of the vascular organs and large vessels of the abdominal organs requires prompt treatment, and as in large engagements a considerable length of time will necessarily intervene between the first aid and the permanent arrest of hemorrhage by laparotomy, and as in many instances the location of the wound is outside of the range of successful treatment by compression of the

abdominal aorta, it appears to me that in such cases it would be good treatment to resort to direct and circular compression as has been described in connection with penetrating wounds of the chest. The wound of entrance and exit, if the latter exists, should be protected by an antiseptic dressing. Over the wound corresponding with the yielding part of the abdominal wall a large compress which may be composed of a compress made of a blanket, an article of clothing, a cartridge belt, or canteen should be placed and over it firm circular compression made with a belt or gunstrap. The direct compression made in the direction of the track of the bullet will do much toward diminishing the vascularity of the underlying injured parts, while the circular compression will immobilize the abdominal wall at the seat of injury and limit the movements of abdominal organs, conditions which can not fail in materially diminishing the risks of hemorrhage and in aiding thrombosis, nature's resource, in effecting spontaneous arrest of hemorrhage.

PERMANENT HEMOSTASIS.—*Forcipressure*.—The best and most successful military surgeon is the one who accomplishes the most with the least number of instruments. Complicated instrument cases look well and make a favorable impression upon laymen, and can be used to advantage in a well-equipped hospital; they are out of place on the battle-field. The fewer the instruments in the treatment of emergency cases, the less the danger of infection. The writer has recently devised an operating pocket case which contains all the instruments a military surgeon is expected to use when in active service. It contains among the instruments needed for emergency work seven hemostatic forceps, by the use of which he is in a position to meet the emergencies incident to hemorrhage upon the battle-field. The use of aseptic hemostatic forceps upon the battle-field will meet the indications successfully in many cases in which other hemostatic

measures are inapplicable. If the bleeding vessel is so located that it can be grasped with hemostatic forceps, but can not be ligated without performing a formidable operation, the forceps should be allowed to remain and should be incorporated in the antiseptic dressing and a note made to this effect on the diagnosis tag.



FIG. 7 a.—Suspender constriction of arm.

Ligature.—Ligation of blood vessels, arteries and veins will usually be done upon the battle-field after temporary hemostasis by other means, either at the first dressing station or, more frequently, at the field



FIG. 8.—Elastic constriction of lower extremity. (After Seydel.)



FIG. 8 a.—Elastic constriction of thigh.

hospital. Silk is the proper ligature material in military service. Silk can be sterilized repeatedly by boiling and is, consequently, a much safer material than catgut in emergency practice. Aseptic silk in an aseptic wound invariably becomes encysted. Catgut sterilized in Boeckmann's sterilizer and kept ready for use in sterilized envelopes, as advised by Boeckmann, could be made serviceable for military surgery. As a rule, the vessel should be tied at the seat of injury by enlarging the existing wound and using it as a guide to the injured vessel. Cases, however, will present themselves in which it is impossible to apply this rule, and where the artery has to be tied in its continuity in a more accessible place on the proximal side of the bleeding point. Antiseptic precautions in the treatment of wounds and the employment of the aseptic ligature will materially diminish, if not entirely overcome, the risk of secondary hemorrhage, which proved such a terror to the surgeons, and such a frequent source of danger and death to the injured during the great War of the Rebellion. The ligature should never be tied sufficiently tight to rupture any of the tunics of the vessel. All that is necessary to obtain an ideal permanent obliteration of the vessel is to approximate and hold in uninterrupted contact the intima. If the vessel requiring ligature in its continuity is a large one, a double ligature with a bloodless space between the two ligatures is preferable, as the space interposed between them offers the most favorable conditions for an early and permanent obliteration of the lumen of the vessel. Under aseptic and antiseptic precautions the ligation of large veins is as safe a procedure as ligation of the accompanying arteries.

Vein Suture and Lateral Ligature.—In small wounds of large veins, lateral ligature and suturing with fine silk or catgut secures permanent hemostasis with preservation of the lumen of the vein, and for these reasons should receive in this kind of vein in-

juries the preference to ligation in continuity. This method of treatment receives particular value in the



FIG. 9.—Antiseptic tamponade of wound of deep palmar arch.
case of wounds of the superior longitudinal sinus
and the large veins at the base of the neck in the

axillæ and the groins, as well as the large veins in the abdominal cavity. The lateral ligature is applied by seizing the margins of the vein wound with a sharp tenaculum and tying the base of the cone with a fine silk or catgut ligature. In suturing of vein wounds the margins are inverted toward the lumen of the vessel in the same manner as in closing an intestinal wound by Lemberi's sutures.

Hot Water and Styptics.—Hot water at a temperature of 120 to 130 degrees F. coagulates the albumin upon the surface of the wound and in doing so seals the orifices of small vessels, and on this account has become a popular hemostatic in arresting parenchymatous bleeding in parts and organs accessible to this method of treatment. The employment of styptics in arresting hemorrhage, on the whole, should be discountenanced, as their use interferes with an ideal healing of the wound. Their application can only come in question in the treatment of bleeding wounds of the mouth and pharynx where antiseptic tamponade is impracticable.

Saline Infusion.—Patients who have become debilitated by hemorrhage to the extent of endangering life, require restoration of a normal degree of intracardiac and intravascular pressure by saline infusion. Transfusion of blood, whole or defibrinated, has been proved clinically and experimentally a failure in preventing death from the immediate and remote results of dangerous hemorrhage. The transfused morphologic elements of the blood do not retain their vitality and are destined to be removed from the receiver sooner or later, by elimination through some of the excretory organs. von Bergmann and others have shown that the immediate cause of death from acute hemorrhage, subnormal intracardiac and intravascular pressure can be avoided more successfully by substituting for animal or human blood a physiologic solution of common salt.

Every field outfit should be supplied with a definite quantity of salt from which the solution can be

prepared in a few moments when required. Szumann's solution is the one usually preferred. It consists of:

Natr. chlorat	6.0
Natr. carbon	1.0
Aq. distillat	1000.0

The chloride and carbonate of soda in the above



FIG. 10.—Treatment of penetrating wound of chest by antiseptic tamponade and immobilization by circular compression.

proportion should be carried in every pannier so as to be available in all cases in which a saline infusion may become necessary. The simplest apparatus for making a saline transfusion is a glass or hard rubber funnel with two or more feet of rubber tubing and a

small glass tube with a tapering point. The median basilic vein is usually selected for making the injection. The vein is exposed by a small incision after having rendered it turgid by proximal compression in the same manner as in performing phlebotomy. After exposure of the vein it is incised transversely, and the point of the glass tube is inserted and fastened in place by a ligature previously inserted. Before inserting the glass tube the precaution is taken to fill it and the rubber tube with the saline solution to prevent the introduction of air. The saline solution to be used should be heated to the



FIG. 11.—Compression of abdominal aorta. (After Esmarch.)

temperature of the body and infection is prevented by using only sterilized water for the solution.

The quantity of solution to be used to fulfill the therapeutic indications will vary from 500 to 1,500 grams, 1,000 grams being a fair average dose, and for the preparation of which the necessary quantity of powder should be kept in readiness. If the symptoms of improvement which follow the employment of a saline infusion should come to a standstill or disappear, it may become necessary to repeat the in-

travenous injection in the course of an hour or more. The same object gained by intravenous injections of salt solution is attained more indirectly and with greater loss of time by copious hypodermatic and rectal injections.

Autotransfusion.—In threatening danger to life from hemorrhage much can be gained from autotransfusion. The exclusion from the general circulation of unessential parts of the body will often secure for the vital organs an adequate blood supply. Autotransfusion for this purpose is secured promptly and efficiently by elastic constriction of one or more extremities at their base. This can be accomplished by Esmarch's constrictor, suspenders, or in the absence of elastic material, by the use of the Spanish windlass. According to the urgency of the symptoms presented, the base of one or more extremities is constricted after rendering the limb comparatively bloodless by elevation. By exclusion of the circulation from one or more extremities, intravascular pressure compatible with essential functions is restored and life is bridged over for a sufficient length of time for the employment of remedies of more lasting value.

Shock.—Next to hemorrhage, shock should receive the surgeon's attention. It is often difficult to differentiate between the symptoms produced by shock and hemorrhage. The non-professional assistant should be made to understand that the maximum symptoms of shock are developed almost immediately after the receipt of the injury, while in hemorrhage the intensity of the symptoms increases progressively. Even in a complete transverse tear of an artery the size of the common carotid, it requires at least five minutes to produce death from hemorrhage in intense shock, symptoms pointing to a fatal issue appear almost immediately upon the receipt of injury. Shock is the result of a reflex vasomotor paresis and, consequently, if severe, calls for the most energetic and prompt treatment. A patient suffering from

shock should be kept in the dorsal recumbent position and treated by active stimulation. Inhalations of nitrite of amyl and hypodermatic injections of strychnia in doses of from one-fifteenth to one-twentieth of a grain, repeated every half hour, until reaction takes place, constitute the most successful treatment. The administration of alcoholic stimulants, camphor and ammonia is also indicated, as well as the external application of dry heat. In the transportation of patients suffering from shock, the greatest care should be exercised not to subject them to any unnecessary movements, and it is of special importance that the recumbent position should be

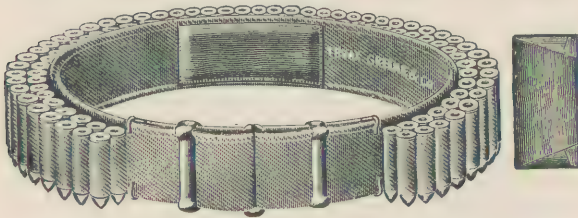


FIG. 12.—Cartridge belt with package sewn on inner surface.

maintained until reaction is established. No operation of any considerable importance should be performed until the patient reacts from the immediate effects of the injury.

Primary Dressing of Wound.—Perfect aseptic surgery upon the battle-field is a happy dream which will probably never be realized. The bullets, as recent experiments have shown, are frequently contaminated with pathogenic microbes, and often carry with them infectious fragments of clothing and other foreign substances, as well as microbes from the surface of the injured part. Again, in large battles the number of wounded is so great and the number of those to whom their treatment is intrusted so small, that the necessary antiseptic precautions to

obtain an antiseptic condition of the wound can not always be carried out. The duty of the surgeon upon the battle-field in rendering the first aid to the wounded, after having given proper attention to the treatment of shock and hemostasis, will be to prevent subsequent contamination of the wound by



FIG. 13.

protecting it with an antiseptic occlusion dressing. Shaving and disinfection of the surface in the vicinity of the wound will be out of the question under such circumstances. Search for bullets and efforts to secure their removal must be postponed until the

patient reaches the field hospital, where these procedures are facilitated and the attending danger of causing infection diminished by a more complete instrumentarium and more efficient means to secure asepticity of the wound and its vicinity.



FIG. 14.

Behind the fighting line, and at the first dressing station, the primary dressing of the wound should consist of the antiseptic package which every soldier should carry with him. The best place where this package should be kept has not been determined.

Esmarch suggests that it should be sewed in some part of the uniform. It appears to me that no part of the clothing of the soldier would be a sufficiently safe place for this most important outfit when in active service. In the heat of battle the soldier often relieves himself of a part of his clothing, his knapsack, but there are two things which he will not part with willingly, and these are the cartridge belt and gun. It appears to me that this package could always be found upon the wounded soldier if it were sewed upon the inner surface of the cartridge belt. The package should be thin and correspond in width with the cartridge belt. Esmarch's package used in the German Army contains: one triangular bandage, one safety-pin, two compresses of salt sublimate mull, 10 cm. wide and 100 cm. long, each wrapped in impermeable paper, one salt sublimate cambric bandage, 10 ctm. broad and 2 m. long. All these articles are wrapped in gutta-percha paper. This package is too cumbersome and contains articles which can be dispensed with in the dressing of wounds upon the battle-field. In the majority of cases the first dressing is only a temporary one and is replaced later when the wound is subjected to thorough examination and treatment by a more efficient one. The package should be as small and compact as possible and should contain only such articles as are absolutely necessary to protect the wound against infection during the interval between the receipt of the injury and the arrival of the patient at the field hospital. Cotton is the most compressible hygroscopic dressing material and the most efficient filter in preventing the access of microbes to the wound. Two drachms or half an ounce of compressed salicylated cotton will furnish the necessary material for a primary occlusion dressing. This can be held in place in almost any part of the body by a triangular gauze bandage, assisted, if circumstances make it necessary, by the cartridge belt, gunstrap, or articles of the patient's clothing. A safe and efficient antiseptic

powder which does not easily deteriorate should invariably constitute a part of the package. A combination of boric and salicylic acid is the one I should propose for this purpose. Two grams of boric acid and half a gram salicylic acid, thoroughly tritu-



FIGS. 13, 14, 15.—Showing primary dressings of the head, upper and lower extremities.

rated, should be incorporated in the center of the compressed cotton, the cotton surrounded by the triangular gauze bandage and with the addition of a safety pin wrapped in gutta-percha tissue.

In applying the dressing, the compressed cotton is loosened, the wound freely dusted with the powder contained in the center of the package, the wound



FIG. 16.—Immobilization of arm and forearm by fastening the sleeve to the coat near the wrist and elbow joints with safety pins and inserting hand underneath coat on opposite side between two buttons.

well covered with the cotton which should overlap its margins, and the dressing held in place by the tri-

angular bandage and such additional extemporized means of retention as may be necessary.

For the purpose of preventing rapid decomposition of the blood which will soon saturate the primary dressing, and with a view of guarding against infection of the wound from this source, it is absolutely necessary to incorporate with the dressing material and bring in contact with the wound a safe and efficient antiseptic which, in this package, consists of a combination of boric and salicylic acid.

Immobilization of Injured Joints and Fractured Limbs.—In the case of fractures and joint injuries, the affected limb should be properly immobilized to prevent additional injury and pain during the transportation of the patient to the field hospital. As it is impossible for the surgeons and Hospital Corps to carry with them upon the battle-field, material for splints in sufficient quantity, they must depend upon articles which can always be found upon the battle-field, in securing for the limb a proper mechanical support. A few of such extemporaneous dressings will be shown in the following figures:

The splint should be well padded with the blanket, or articles of wearing apparel. In compound fractures and penetrating wounds of joints, perfect immobilization by a plaster-of-Paris splint should be secured as soon as possible, but as this can not be done behind the fighting line, for obvious reasons, the temporary improvised dressing should be replaced by the permanent fixation dressing at the field hospital. Antiseptic precautions and perfect immobilization will be the most important elements in the conservative treatment of compound fractures and penetrating injuries of large joints.

Transportation of Sick and Wounded.—Increased and improved facilities for rapid transportation of the wounded from the fighting line to a place of safety, will be an essential requirement in securing the greatest amount of benefit from conservative surgery upon future battle-fields. The general intro-

duction of the new infantry weapon will make it necessary to establish the field hospital farther in the rear of the line of battle than formerly. Unless a natural protection by a hill or deep ravine is avail-



FIG. 17.—Mitella by fastening lapel of coat on injured side with two safety pins in such a position as to support the forearm in a flexed position.

able, it will be necessary to locate the field hospital at least 3,000 meters from the line of action. This will necessitate an improved ambulance service. The latter will be resorted to in transporting the severely wounded from the point where the first aid is rendered to the first dressing station.

A well-trained Hospital Corps, and the use of improved litters and ambulances will be instrumental in securing prompt and easy conveyance of the wounded from the line of duty to their destination. An efficient bicycle litter is a much needed desideratum in the transportation of the wounded from the fighting line to the first dressing station and field hospital.

The Surgeon's Work at the Field Hospital.—The conservative work begun on the battle-field is continued at the field hospital, which offers additional facilities for the practice of ideal conservative surgery. It is here that efficient measures can be employed to correct the injurious effects of profuse hemorrhage and to overcome the symptoms of prolonged shock. It is here that every serious wound will be thoroughly examined and under strict antiseptic precautions will be subjected to the necessary treatment. It is here where permanent hemostasis will be substituted for temporary measures. It is here that the abdomen and cranial cavities will be opened for penetrating wounds requiring such intervention for the arrest of hemorrhage, the removal of foreign infected bodies and the direct treatment of visceral wounds. It is here that permanent plaster-of Paris splints will be substituted for the temporary fixation dressings, in cases of compound fractures and penetrating wounds of joints.

Indications for Probing and Extraction of Bullet.—The modern small caliber bullet will render a resort to the bullet probe much less frequent than was the case in the wars of the past. Owing to its greater velocity and power of penetration it will pass through the different parts of the body, regardless of the

resistance offered by the osseous structures at a distance intended for shooting to kill. In the presence of a wound of entrance and exit, the use of the probe should be dispensed with, as an exploration of this

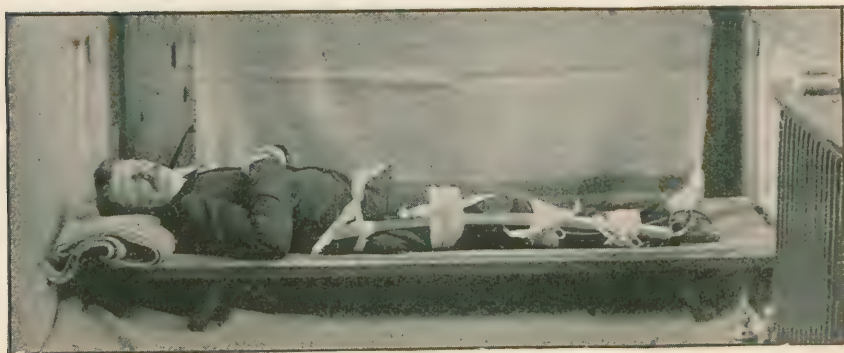


FIG. 18.—Saber splint for leg and thigh.

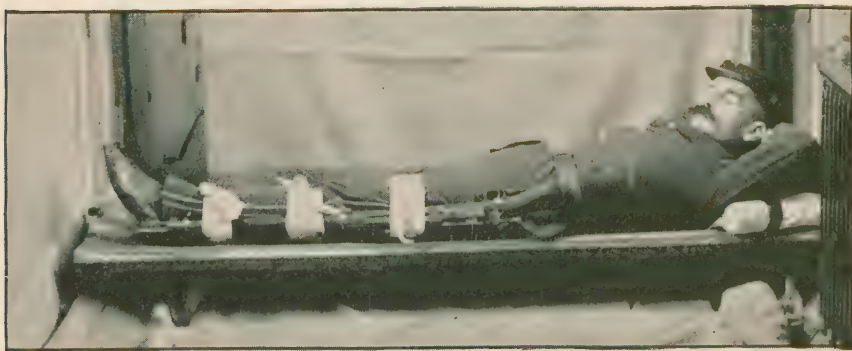


FIG. 18 a.—Gunsplint.

kind would yield no indications of diagnostic value and might become a source of infection or a cause of renewal of hemorrhage. The jacketed bullet is less liable to undergo deformation in striking a hard

object such as bone, and is also less likely to become deflected than the leaden bullet. Additional modifications of the character of the bullet wounds will render the use of the probe less frequent in the future than the past. Search for the bullet under antiseptic precautions is justifiable in gunshot fractures, penetrating wounds of the cranium and joints. It is absolutely contra-indicated in penetrating wounds of the chest and abdomen. In bullet wounds of the soft parts, an attempt in this direction is warranted when the surgeon has reason to believe that the bullet is located



FIG. 19.—Stick and blanket splint.

in a place accessible to its safe removal. Probing for bullets, on the whole, has done more harm than good in the past, and the limits of the indications for this procedure will be greatly narrowed in the future. If the bullet can not be removed without performing a formidable operation it is much better to permit it to remain and wait for additional indications than subject the patient to additional risks incident to the operation. The modern bullet in an antiseptic wound will become encysted like the leaden bullet and, in the majority of cases, will remain permanently in the tissues as a harmless foreign sub-

stance. If the nature of the injury makes the search for and an attempt at its removal necessary, the exploration should be made systematically and under the strictest antiseptic precautions.

The metal jacket of the modern bullet detracts from the value of the famous Nélaton probe, and has made the equally famous American bullet forceps obsolete as an instrument of extraction. The porcelain bulb of Nélaton's probe will, however, answer a useful purpose in following the track made by the bullet and in demonstrating the presence of a foreign substance in the soft tissues. The porcelain bulb of the ordinary Nélaton's bullet probe is too small, especially in searching for bullets of large caliber. It is much easier to follow the tubular wound made by a bullet with a probe, the porcelain bulb of which approximately corresponds in size with that of the bullet. As in instrumentation of the urethra, a false passage is more likely to be made with a small than a large instrument. I have had a bullet probe made which is supplied at both ends with a porcelain bulb, one of which corresponds in size with a 22 caliber bullet, the other with that of a 38 caliber.

The porcelain bulb of the ordinary probe is very liable to become detached in exploring deep wounds, and may be lost in the wound, as happened in one of my cases. To prevent such an accident, the bulbs of my probe are drilled through, the ends of the silver probe pass through, and are clinched in a depression on the surface of the bulb. In searching for bullets it is of the greatest importance to bring the parts and tissues of the body as nearly as possible in the exact position they occupied when the injury was received. That no more force should be employed in using the bullet probe than in passing a catheter is simply to repeat a cardinal rule to which there should be no exceptions. Skill in the delicate manipulation of the instrument, patience and perseverance will accomplish more than force in these cases. Bullets

which can be felt under the skin opposite the wound of entrance are extracted without exploration of the wound canal. If the bullet occupies a locality where its presence would be incompatible with a good functional result, as the cavity of a large joint, it becomes



FIG. 20.—Bark splint for forearm and wire splint for arm.

usually necessary to enlarge the wound with the knife, chisel and mallet to follow the course of the bullet and to effect its extraction. In one case I removed a 22 caliber bullet from the center of the knee joint by such a procedure, in a boy 14 years of



FIG. 21.—Litter transportation.

age, who recovered with nearly perfect use of the limb. A similar case is reported by Volkmann. The metal jacket of the modern bullet will make it necessary to construct bullet forceps with great grasping power to facilitate its extraction. In penetrating gunshot wounds of the skull, Flührer's aluminum probe and his technique in removing a bullet from the cranial cavity merit the earnest attention of every military surgeon.

Craniectomy.—Operative interference is indicated in every case of penetrating gunshot or stab wound of the cranium. The object of such operation is to secure asepticity of the wound and its environment, removal of loose spicula of bone and infected foreign substances, arrest of hemorrhage by torsion, ligation or tamponade and, if feasible, removal of the bullet.

The wound of entrance is enlarged with chisel or rongeur forceps sufficiently to enable the surgeon to meet the indications for the operation. If the bullet is lodged in the interior of the skull, it may become necessary to make a circular craniectomy in the course of the bullet at a point opposite the wound of entrance, for the purpose of establishing thorough drainage and to facilitate the removal of the bullet.

Laparotomy.—In my address at the last annual meeting, I discussed the advisability and feasibility of laparotomy upon the battle-field in cases of penetrating bullet and stab wounds of the abdomen, and I shall not occupy your time on this occasion by further remarks on this subject.

Amputation.—The object of conservative surgery upon the battle-field, as well as in civil practice is to obviate, whenever possible, the necessity of mutilating operations. Prompt and careful hemostasis, antiseptic precautions, immobilization of compound fractures and injured joints, and early and careful transportation of the wounded from the field to the temporary hospital are the most fruitful resources of the modern military surgeon in the prevention of complications that so often necessitated intermediate



FIG. 22.—Manner of transferring patient from litter to ambulance.

and secondary amputations in the wars of the past. A primary amputation for gunshot wound of the extremities is only justifiable by extensive injuries of soft parts and fractures and joint wounds complicated by injury of large vessels and nerves. In other words, the indications for a primary amputation will be studied and sought for, more by the character and extent of the injury of the soft tissues than the extent of the bone or joint lesion. In doubtful cases the patient will be given the benefit of the doubt, as under antiseptic precautions the risk to life is greatly diminished in the attempt to save a limb by conservative treatment. The conditions which will demand an intermediate or secondary amputation in cases thus treated will prove less perilous to life than in the past, an additional inducement to practice conservatism in doubtful cases.

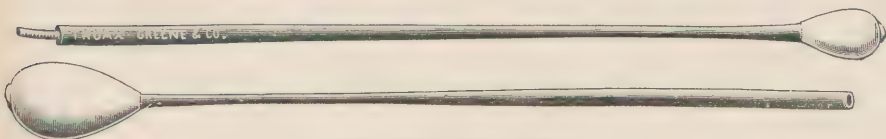


FIG. 23.—Senn's bullet probe.

Resection.—Primary resection for gunshot wounds of joints for obvious reasons has become an obsolete operation in modern military surgery. The most brilliant results have already been obtained by conservative treatment of such cases. The military surgeon will make it his duty in such instances to resort to such measures as will prevent complications necessitating secondary resection and amputation. Thorough disinfection of the wound, removal of loose fragments of bone and infected foreign substances including the extraction of the bullet, if this is found within or in the immediate vicinity of the injured joint, gauze drainage and immobilization of the limb in a circular plaster-of-Paris splint are the most effective measures in accomplishing this end.

I have briefly sketched in this paper the essential

topics which will engage the attention of the military surgeon in the future in keeping pace with the rapid advances of modern surgery; and which will enable him to extend the blessings of conservative surgery to the wounded upon the battle-field of the future. The members of this Association should regard it as their duty to so perfect themselves in the principles and details upon which rests ideal conservative surgery, as to apply it in practice should they be called upon to serve their country upon the battle-field.





